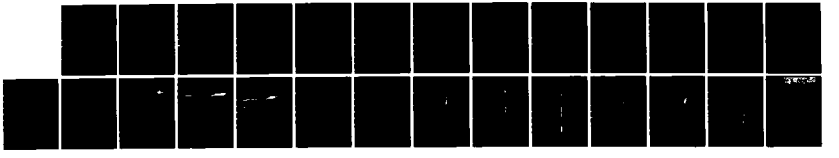
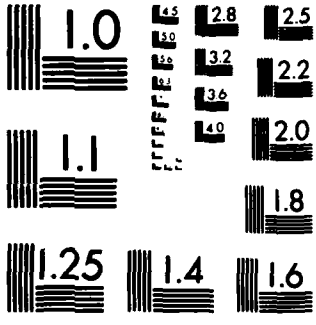
AD-A146 897 ON-ORBIT SUPPORT OF DARPA-301 PAYLOAD(U) LOCKHEED 1/1
MISSILES AND SPACE CO INC PALO ALTO CA
W L IMHOF ET AL. 28 SEP 84 LMSC/F018810
UNCLASSIFIED N00014-84-C-0304 F/G 22/1 NL





OPY RESOLUTION TEST CHART

AD-A146 897

(12)

LMSC/F018810

D216

28 September 1984

FINAL REPORT

ON-ORBIT SUPPORT OF DARPA-301 PAYLOAD

CONTRACT N00014-84-C-0304

Submitted To:

Department of the Navy
Office of Naval Research
800 North Quincy Street
Arlington, Virginia 22217

W. L. Imhof
D. W. Datlowe
J. Mobilia
G. H. Nakano
E. E. Gaines
J. R. Kilner

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Lockheed Missiles & Space Company, Inc.

Research and Development
3251 Hanover Street, Palo Alto, California 94304

In reply refer to:
LMSC/F033149

28 September 1984

To: Office of Naval Research
800 North Quincy Street
Arlington, Virginia 22217

Attn: Mr. R. Gracen Joiner, Code 414

Subject: Contract N00014-84-C-0304
On Orbit Support of DARPA-301 Payload

Encl: (1) One (1) copy of Final Report under subject contract entitled, "On-Orbit Support of DARPA-301 Payload" (LMSC/F018810) dated 28 September 1984

(2) Material Inspection and Receiving Report (DD Form 250) (One (1) original copy)

1. Pursuant to the requirements of subject contract, the enclosed final report is submitted.

2. Additional distribution is being made in accordance with contract requirements.

3. This submission completes the effort under subject contract. Pursuant to Sequence A002 of the Contract Data Requirements List of subject contract, the Contractor submits the enclosed Material Inspection and Receiving Report (DD Form 250) as Enclosure (2). It would be appreciated if you would complete the DD Form 250 as follows and return the signed original to the undersigned:

(a) In Block 21.B, put an "X" in the acceptance block, fill in the date, type in name and title, and sign.

(b) In Block 22, fill in the date, type in name and title, and sign.

4. The Contractor appreciated the opportunity to perform subject contract and looks forward to further efforts on behalf of the Office of Naval Research.

5. Should there be a requirement for further discussion, please telephone the undersigned at (415)424-2001. Further correspondence and the signed original of the DD Form 250 should be mailed to the attention of the undersigned at Department 50-11, Building 253 at the above Palo Alto address.

LOCKHEED MISSILES & SPACE COMPANY, INC.
Advanced Systems Division

D. E. Dorset
Contract Administration

DED:slr

cc: Naval Plant Representative Office
Lockheed Missiles & Space Company, Inc.
P.O. Box 3504
Sunnyvale, California 94088-3504
Attn: SPL 54 (w/1 cy encl (1) only)

Director
Naval Research Laboratory
Washington, D. C. 20375
Attn: Code 2627 (W/6 cys encl (1) only

✓Defense Technical Information Center, Bldg 5
Cameron Station
Alexandria, Virginia 22314 (w/12 cys encl (1) only)

I. INTRODUCTION

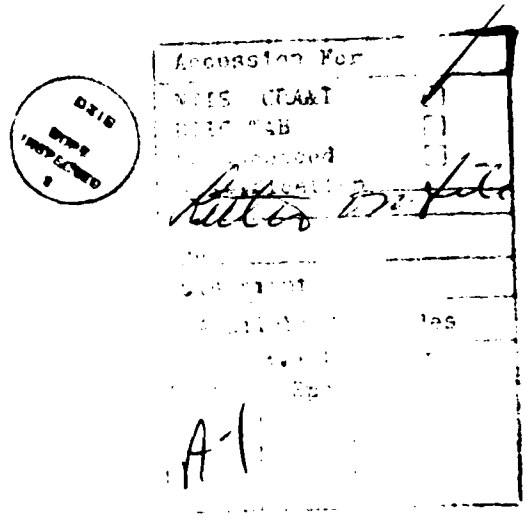
This report covers the following activities in support of the DARPA-301 payload on the P78-1 satellite. As discussed in the report, several gamma-ray detectors with high sensitivity continue to perform well and are completely capable of fulfilling the mission objectives. These objectives are:

(A) Provide the technical planning and liaison with the Air Force Satellite Control Facility and other government agencies as required for the on-orbit satellite support of the DARPA-301 payload during the period ending 30 September 1984.

(B) Assess the on-orbit operation and quality of data from the DARPA-301 payload on the P78-1 satellite;

(C) Provide support, including quick-look analysis and interactions with the Air Force Satellite Control Facility, for a regional event; and,

(D) Perform regular analyses of the on-orbit data to maintain updated evaluations of the sensitivities and optimum configurations of the payload for mapping gamma-ray sources.



II. TECHNICAL PLANNING AND LIAISON WITH SATELLITE CONTROL FACILITY

During the course of this program we have been interacting with the Satellite Control Facility on almost a daily basis. Many of these interactions have been by telephone, but one or more representatives of the Space Sciences Laboratory generally goes to the Satellite Control Facility at least once a week. On these visits the status of the satellite is usually considered in detail and we often make suggestions for future action. The operation of the DARPA-301 payload is usually discussed and plans often made for the operation of the mechanical refrigerators. The electrical configuration of the entire payload has also been changed on occasion to balance the spacecraft power loads. In addition, several "quick-look" tapes are generally picked up and taken back to the Palo Alto Laboratory for processing.

We have also participated in a variety of special meetings, and, when appropriate, comments and recommendations are made. One major meeting and several interactions in 1984 have been concerned with operation and conditioning of the spacecraft batteries. These have been in response to the several spacecraft undervoltage conditions that have been encountered during the course of the year. Another meeting in which we participated in 1984 was concerned with the operations during Regional Events. That meeting was attended by J. Shrum, Major Brovetto, Capt. Cruz, Lt. Price, and several members of the Lockheed Palo Alto Research Laboratory.

III. ASSESS ON-ORBIT OPERATIONS AND QUALITY OF DATA

On a regular basis, often once a week or more frequently, the flight data tapes are sometimes subjected to quick-look analyses. These analyses are generally based on strip-chart plots of the various instrument outputs. In this manner the general quality of the flight data is assessed, and the instrument performance sometimes subjected to a detailed evaluation. An example of these strip charts is shown in Figure 1.

On occasion we have been asked by the mission team at the Satellite Control Facility to process special playback tapes in order to assess the quality of the data received. These special operations have involved each of the tracking stations at various times. As with most of the quick-look data a special effort is often made to insure that the turnaround time from receipt of the tapes to completion of the quick-look processing is less than 2-3 days.

IV. REGIONAL EVENTS

Although there was no regional event coverage during the time period covered by this report, data were regularly recorded once each day and night in the region of interest. These data provide good information on the background levels and will be very important for in evaluating flight data during a regional event.

We have also kept in touch with the customer to be aware of any anticipated special coverages so that the payload configuration could always be in an optimized condition.

There has been one opportunity for special coordinations involving the DARPA-301 payload. The necessary ephemeris runs were made and the payload set in a mode to record at the appropriate times, but the results were negative.

V. ANALYSES OF ON-ORBIT DATA

The key instruments in the DARPA-301 payload for fulfilling the mission at the times of interest are the gamma-ray detectors with the highest sensitivity. These have proven to be the large sodium iodide anti-coincidence shields surrounding the germanium spectrometers. As discussed below they are still performing. The germanium sensors themselves are operational but in recent months the lowest temperatures we have been able to reach with the Stirling cycle refrigerators are ~ ($180^{\circ}K$ - $190^{\circ}K$). Such temperatures are slightly too high to operate the spectrometers. Considerable effort with the SCF has been devoted to running the refrigerators. They have been operated in various configurations and subjected to a variety of warm-up cycles. The latter procedures have often resulted in achieving lower temperatures, but the sensor temperatures are generally not sufficiently low to permit applying bias to the germanium detectors. However, it should be emphasized that the inability to achieve low temperatures results only in loss of high resolution spectral data and gamma rays can still be detected and tracked with high sensitivity.

Six of the GEMS 002 cadmium telluride spectrometers are still operating, although two of these at times have displayed intermittent action. In addition, the cesium iodide anti-coincidence counters surrounding the cadmium telluride sensors are still performing and these are very sensitive for detecting gamma-ray sources in the atmosphere. The two GEMS 001 cesium iodide scintillators are no longer operational, but comparable sensitivities are achieved with the anticoincidence counters around the cadmium telluride sensors and the germanium spectrometers.

The solid state spectrometers (EEM 002, PRM 004, LEP 002) for measuring electrons and protons are still performing well. The EEM 002 spectrometer is

probably the most useful of the particle detectors for the missions of prime interest in that it serves to monitor the local electron background and also can measure in detail with high sensitivity any injected electrons.

When the flight data are surveyed for general quality, the outputs of individual instruments are also studied in detail to determine their sensitivites for mapping gamma-ray sources. Bremsstrahlung x-ray sources, which are often present in the high latitude regions of the auroral zone, prove to be very useful in evaluating the response of the GEMS 2 spectrometers to x-rays. Examples of the strip charts of such data are shown for an unusually strong event in Figure 2. More detailed plots of the performance of each of the GEMS counters are shown in Figure 3.

Since the anti-coincidence counters surrounding each of the germanium sensors have proven to be very effective for tracking gamma-ray sources in the atmosphere, considerable effort has been spent in evaluating the performance of these sensors. Examples of the various sensor outputs including the anti-coincidence counters are shown in Figure 4, 5 and 6. The anti-coincidence counters have been run at various threshold levels and the counting rates in similar locations at those thresholds are shown in Figure 7 for night data and Figure 8 for daytime data.

Since locally trapped electrons often provide a serious background for gamma-ray mapping spectrometers, the Energetic Electron Monitor (EEM 002) is a very important part of the DARPA-301 payload. In some events the direct measurement of electrons is also of great interest. We have therefore kept very close track of the performance of the EEM spectrometer. Examples of the EEM response are provided in Figures 9, 10, and 11. The trapped, precipitating, and backscattered electron fluxes are shown for a portion of an orbit. Examples of

the energy spectra are shown in Figure 12. Similar outputs of the LEP detector are plotted in Figures 13 and 14.

VI. SUMMARY

In summary, we have provided on-orbit support of the DARPA-301 payload through September 1984. The instruments are still capable of satisfying the mission objectives and it is therefore important that such support continue.

ACKNOWLEDGEMENTS

The efforts of Mr. J. McGlennon and Mr. C. Chalmers in processing the DARPA 301 data are greatly appreciated. Consultations with Dr. H. D. Voss are also acknowledged.

FIGURE CAPTIONS

Figure 1. An example of a strip chart showing selected outputs of the DARPA-301 payload on the P78-1 satellite.

Figure 2. Selected outputs of the DARPA-301 payload during a strong bremsstrahlung x-ray event.

Figure 3. Output of the GEMS 2 Aa detector during the x-ray event shown in Figure 2.

Figure 4. Strip chart outputs of selected sensors in the DARPA-301 payload.

Figure 5. Strip chart outputs of selected sensors in the DARPA-301 payload.

Figure 6. Strip chart outputs of selected sensors in the DARPA-301 payload.

Figure 7. Counting rates in the Gamma 003 anti-coincidence counter at various threshold settings during nighttime passes over a similar region of space.

Figure 8. Counting rates in the Gamma 003 anti-coincidence counter at various threshold settings during daytime passes over a similar region of space.

Figure 9. The EEM spectrometer counting rates during a portion of an orbit.

Figure 10. The EEM spectrometer counting rates during a portion of an orbit.

Figure 11. The EEM spectrometer counting rates during a portion of an orbit.

Figure 12. Examples of the electron energy spectra measured in the EEM spectrometer.

Figure 13. The LEP spectrometer counting rates during a portion of an orbit.

Figure 14. The LEP spectrometer counting rates during a portion of an orbit.

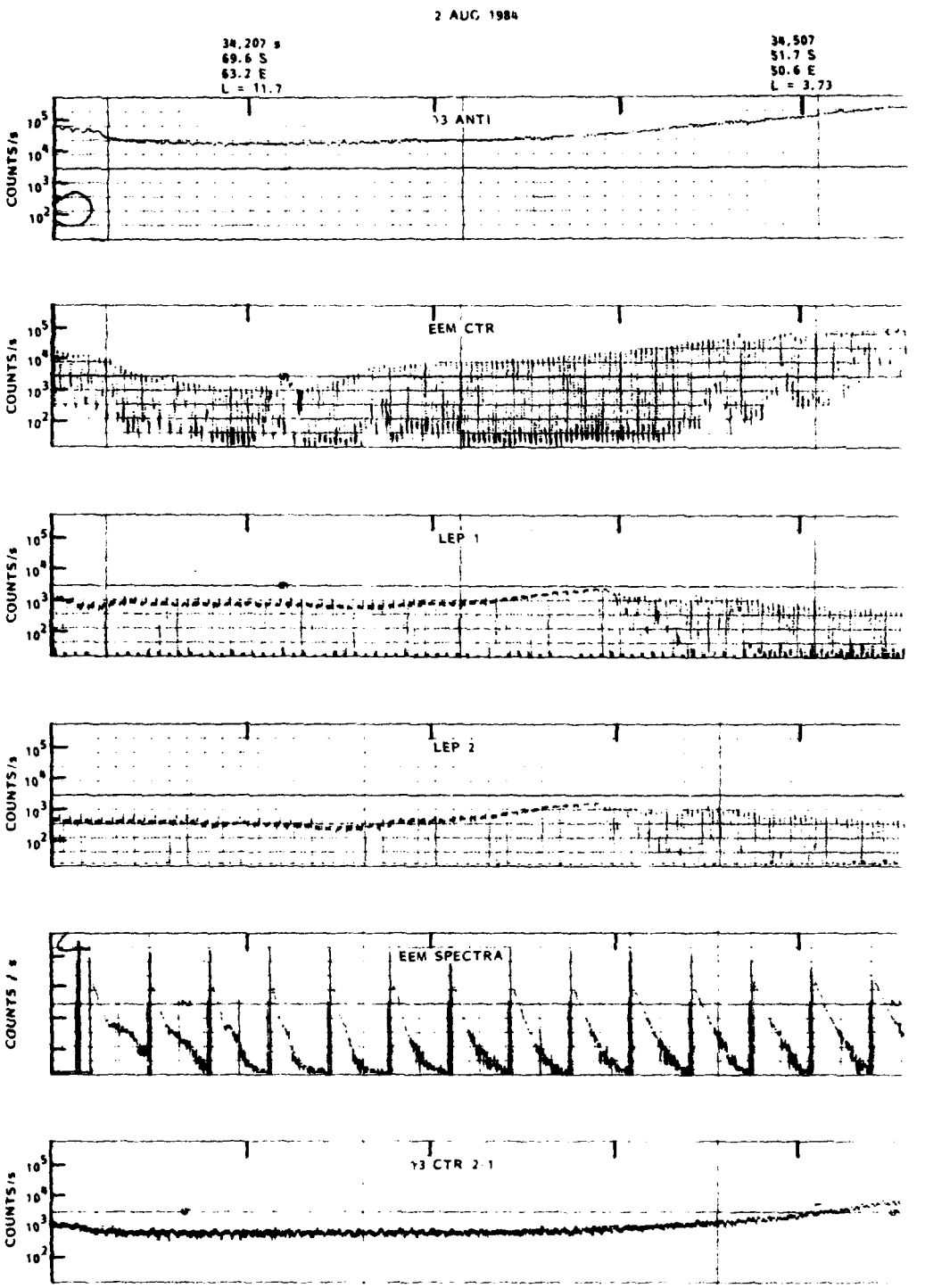

2 AUG 1984
34,207 s
69.6 S
63.2 E
L = 11.7
34,507
51.7 S
50.6 E
L = 3.73
COUNTS/s
EEM CTR
LEP 1
LEP 2
EEM SPECTRA
COUNTS / s

Figure 1

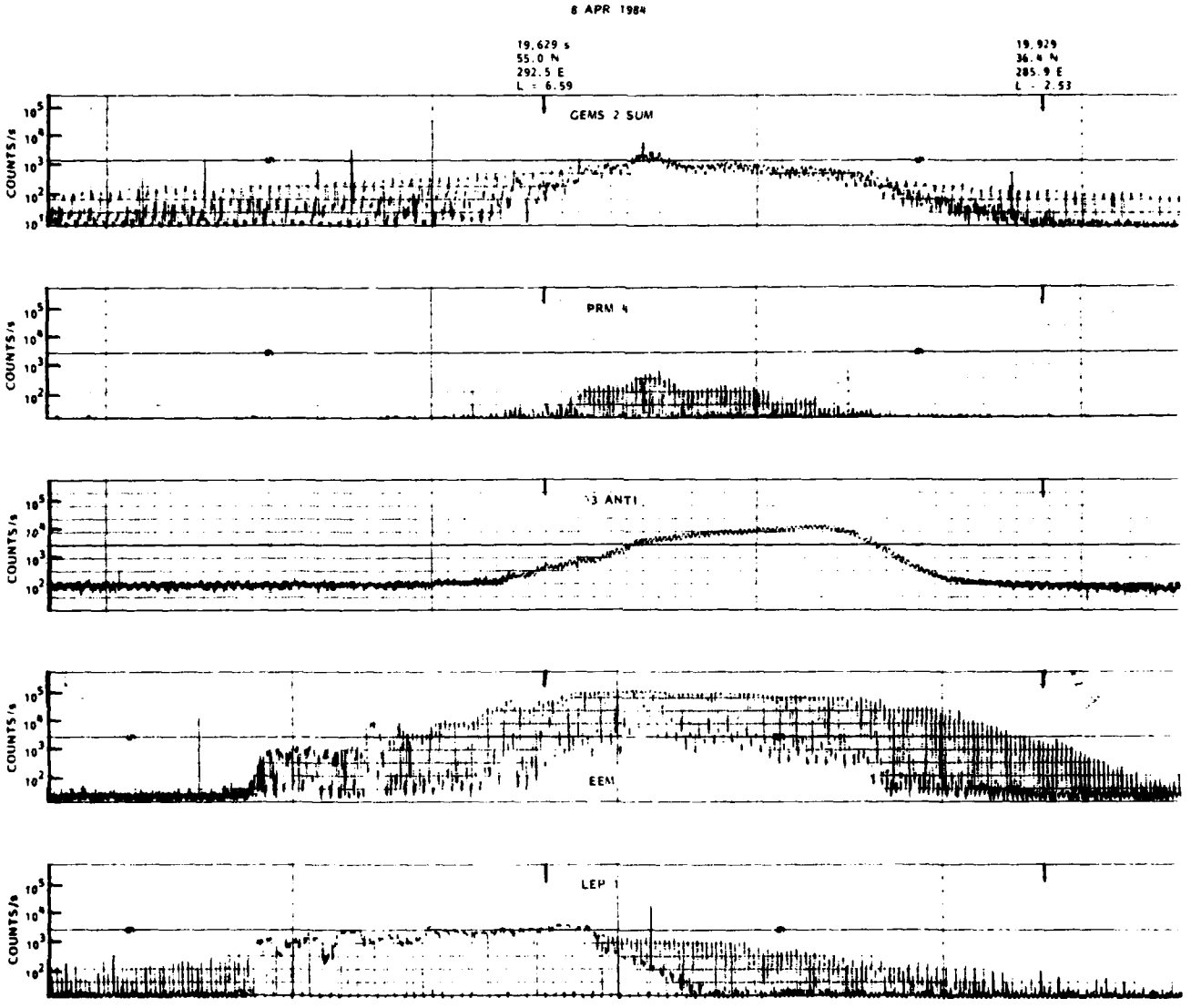

8 APR 1984
19,629 s
55.0 N
292.5 E
L = 6.59
19,929
36.4 N
285.9 E
L = 2.53
GEMS 2 SUM
PRM 4
3 ANTI
EEM
LEP 1
COUNTS/s

Figure 2

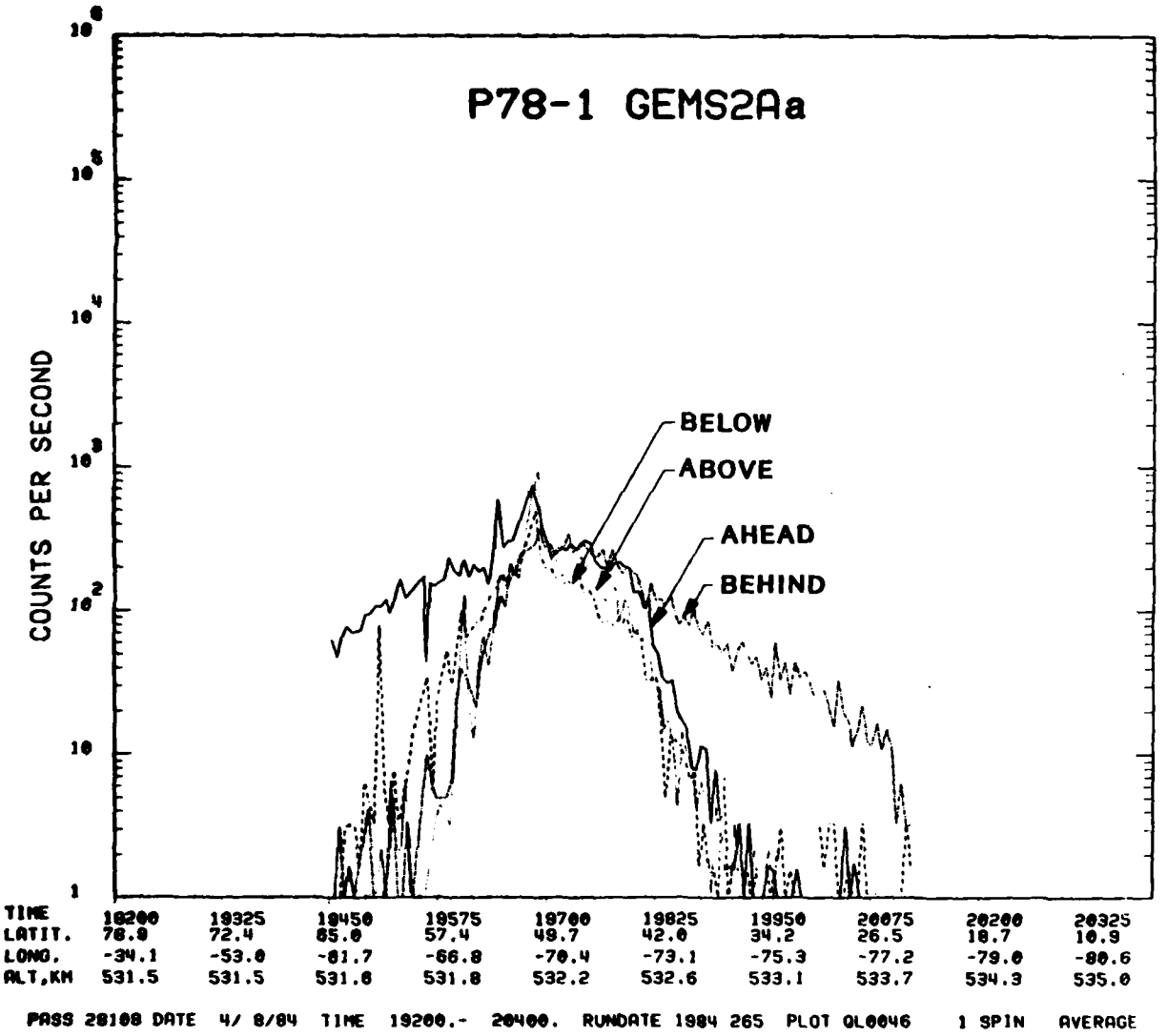

P78-1 GEMS2Aa
COUNTS PER SECOND
BELOW
ABOVE
AHEAD
BEHIND
TIME 19200 19325 19450 19575 19700 19825 19950 20075 20200 20325
LATIT. 78.8 72.4 65.0 57.4 49.7 42.0 34.2 26.5 18.7 10.9
LONG. -34.1 -53.0 -61.7 -66.8 -70.4 -73.1 -75.3 -77.2 -79.0 -80.6
ALT,KM 531.5 531.5 531.8 531.8 532.2 532.6 533.1 533.7 534.3 535.0
PASS 28108 DATE 4/ 8/84 TIME 19200.- 20400. RUNDATE 1984 265 PLOT QL0046 1 SPIN AVERAGE A1

Figure 3

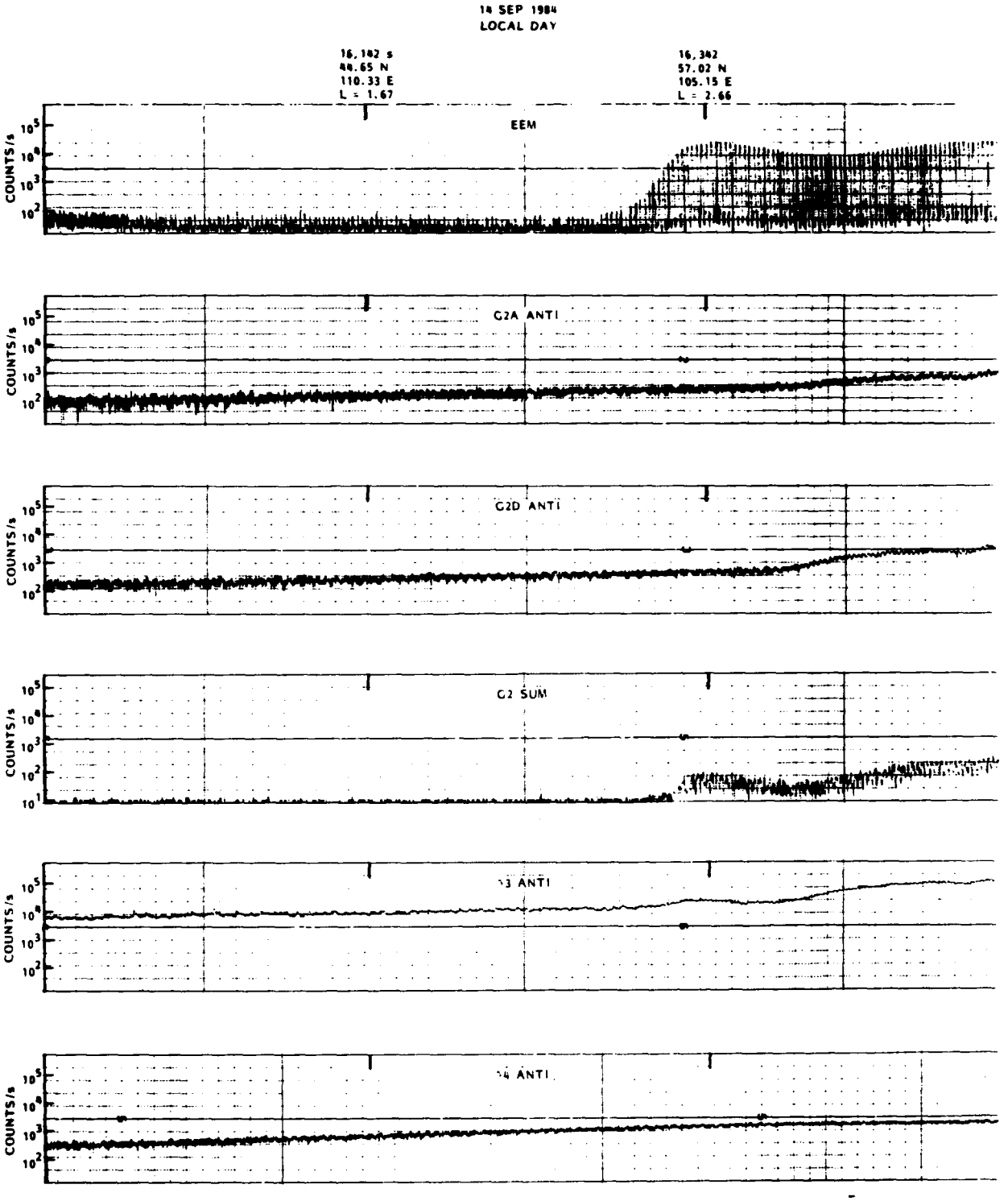

14 SEP 1984
LOCAL DAY
16,182 s
48.65 N
110.33 E
L = 1.67
16,382
57.02 N
105.15 E
L = 2.66
EEM
G2A ANTI
G2D ANTI
G2 SUM
G3 ANTI
G4 ANTI
COUNTS/s

Figure 4

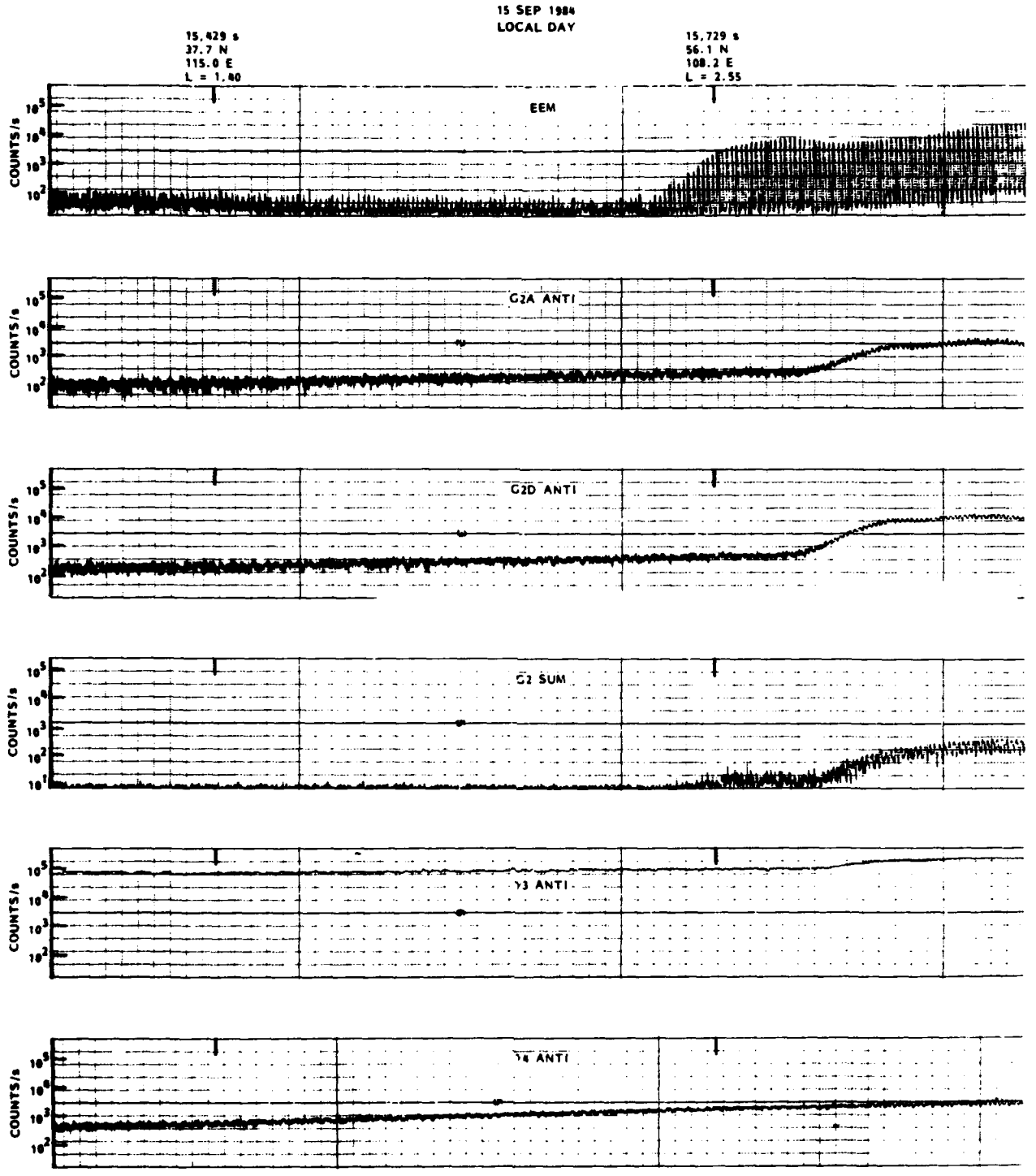

15 SEP 1984
LOCAL DAY
15,429 s
37.7 N
115.0 E
L = 1.40
15,729 s
56.1 N
108.2 E
L = 2.55
EEM
G2A ANTI
G2D ANTI
G2 SUM
Y3 ANTI
Y4 ANTI
COUNTS/s

Figure 5

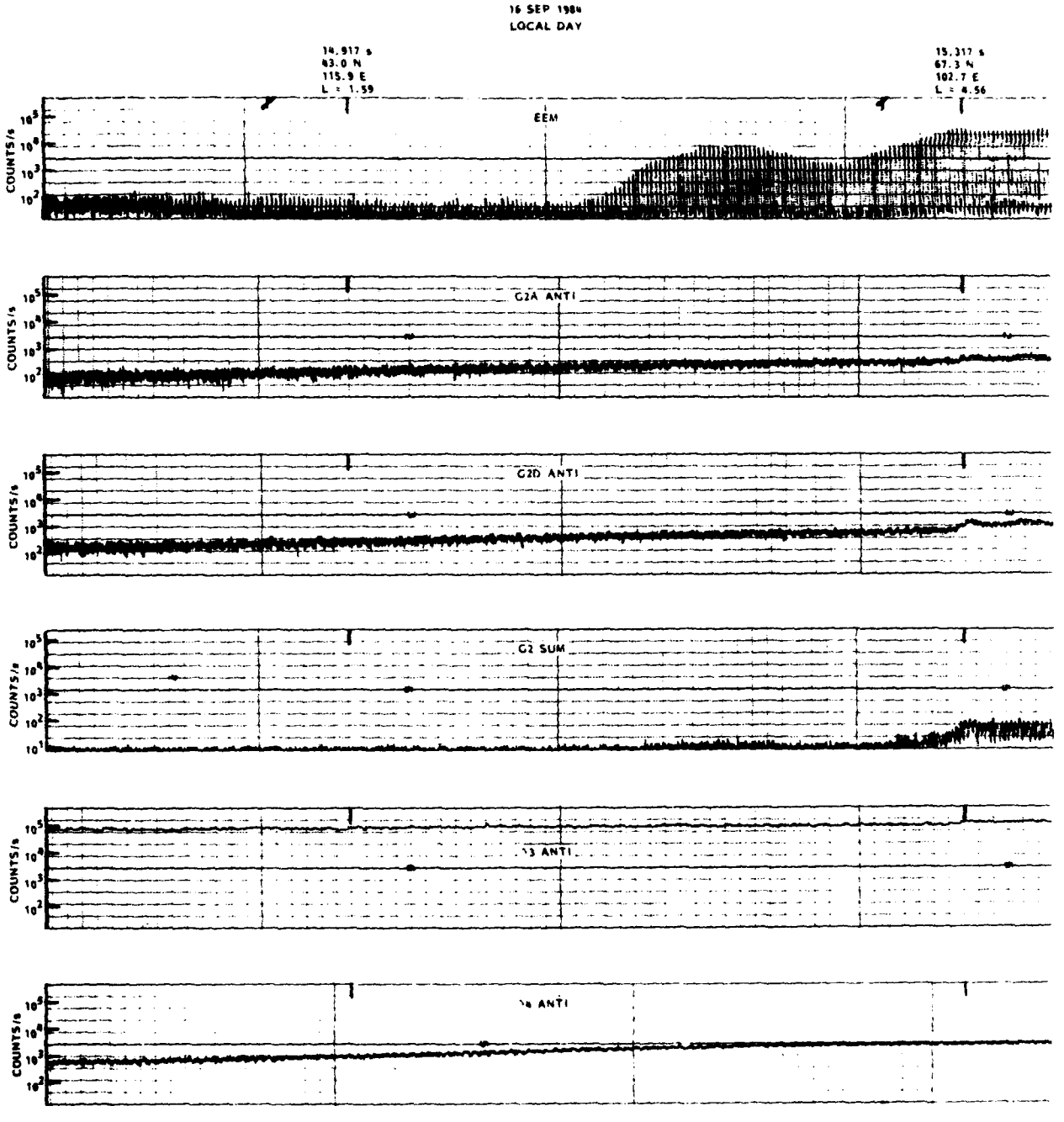

16 SEP 1984
LOCAL DAY
14.917 s
83.0 N
115.9 E
L = 1.59
15.317 s
67.3 N
102.7 E
L = 4.56
EEM
G2A ANTI
G2D ANTI
G2 SUM
COUNTS/s

Figure 6

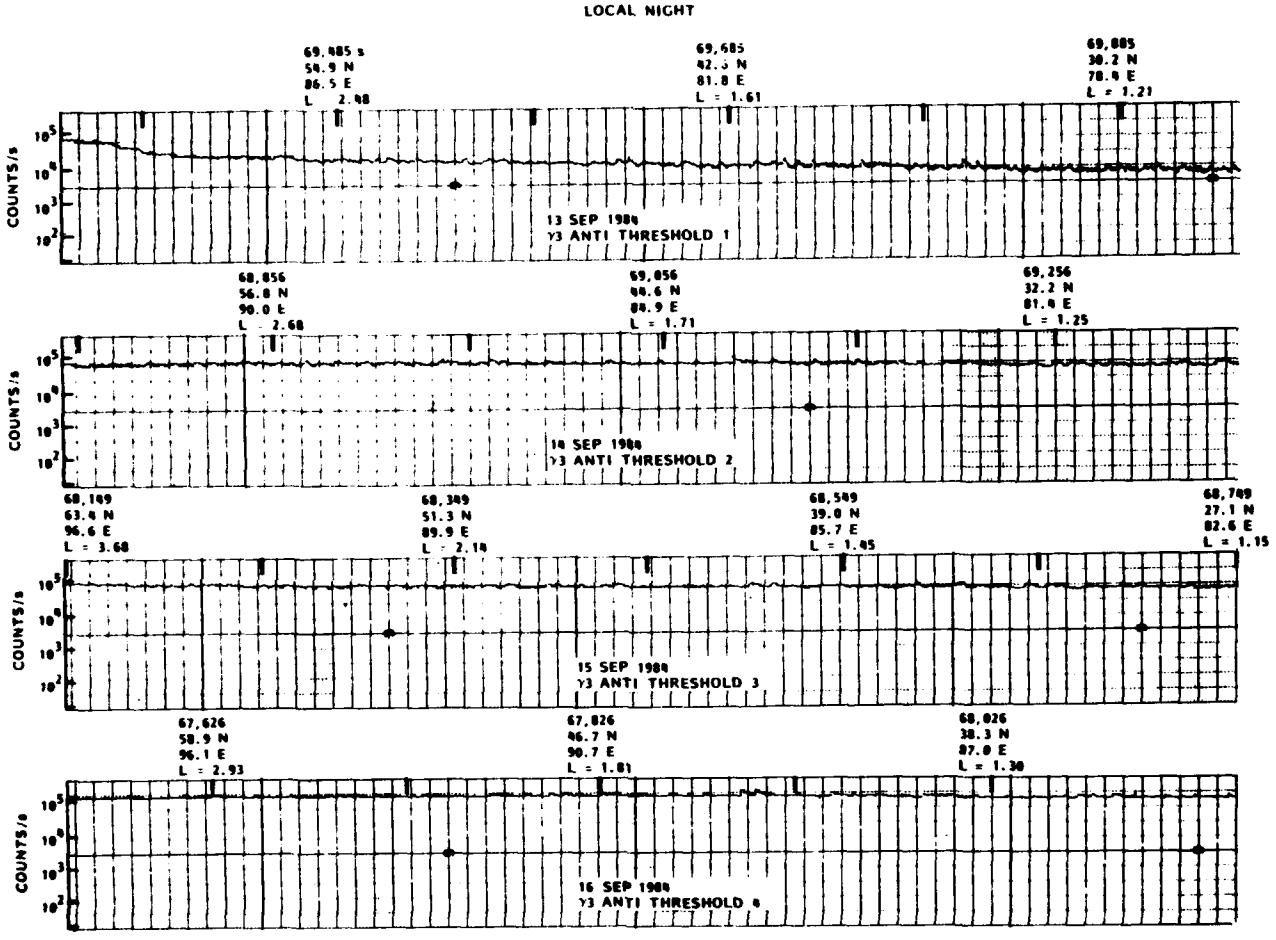

LOCAL NIGHT
69,485 s
58.9 N
86.5 E
L = 2.48
69,685
42.5 N
81.8 E
L = 1.61
69,885
30.2 N
78.4 E
L = 1.21
COUNTS/s
13 SEP 1984
Y3 ANTI THRESHOLD 1
68,856
56.8 N
90.0 E
L = 2.68
69,056
48.6 N
88.9 E
L = 1.71
69,256
32.2 N
81.4 E
L = 1.25
14 SEP 1984
Y3 ANTI THRESHOLD 2
68,149
63.4 N
96.6 E
L = 3.68
68,349
51.3 N
89.9 E
L = 2.14
68,549
39.0 N
85.7 E
L = 1.45
68,749
27.1 N
82.6 E
L = 1.15
15 SEP 1984
Y3 ANTI THRESHOLD 3
67,626
58.9 N
96.1 E
L = 2.93
67,826
46.7 N
90.7 E
L = 1.81
68,026
38.3 N
87.0 E
L = 1.30
16 SEP 1984
Y3 ANTI THRESHOLD 4

Figure 7

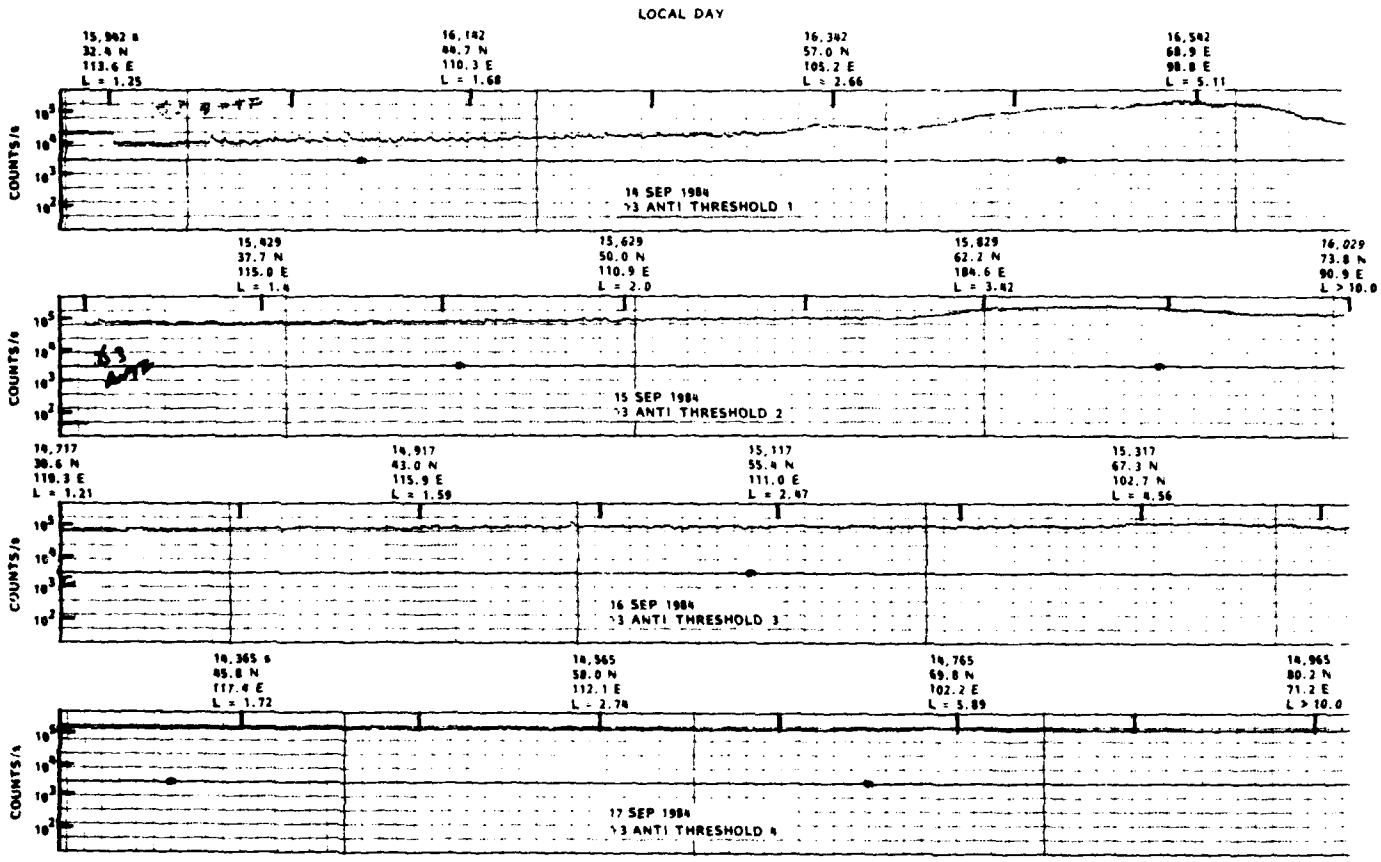

LOCAL DAY
15,902 s
32.4 N
113.6 E
L = 1.25
16,102
40.7 N
110.3 E
L = 1.68
16,302
57.0 N
105.2 E
L = 2.66
16,502
68.9 E
98.8 E
L = 5.11
COUNTS/s
14 SEP 1984
>3 ANTI THRESHOLD 1
15,829
37.7 N
115.0 E
L = 1.4
15,629
50.0 N
110.9 E
L = 2.0
15,829
62.2 N
104.6 E
L = 3.42
16,029
73.8 N
90.9 E
L > 10.0
COUNTS/s
15 SEP 1984
>3 ANTI THRESHOLD 2
14,717
30.6 N
119.3 E
L = 1.21
14,917
43.0 N
115.9 E
L = 1.59
15,117
55.4 N
111.0 E
L = 2.47
15,317
67.3 N
102.7 E
L = 4.56
COUNTS/s
16 SEP 1984
>3 ANTI THRESHOLD 3
14,365 s
45.8 N
117.4 E
L = 1.72
14,565
58.0 N
112.1 E
L = 2.74
14,765
69.8 N
102.2 E
L = 5.89
14,965
80.2 N
71.2 E
L > 10.0
COUNTS/s
17 SEP 1984
>3 ANTI THRESHOLD 4

Figure 8

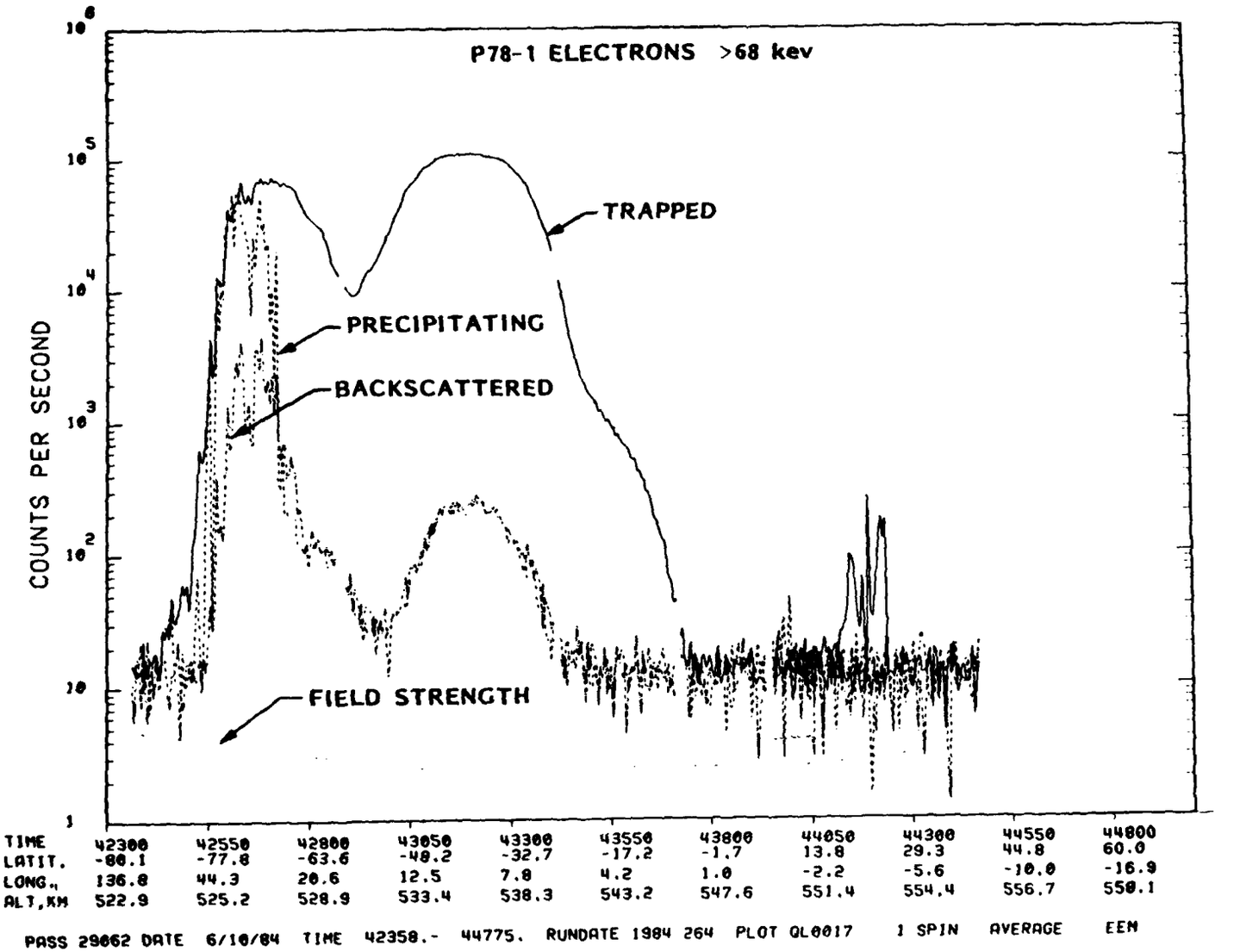

P78-1 ELECTRONS >68 kev
COUNTS PER SECOND
TRAPPED
PRECIPITATING
BACKSCATTERED
FIELD STRENGTH
TIME 42300 42550 42800 43050 43300 43550 43800 44050 44300 44550 44800
LATIT. -80.1 -77.8 -63.6 -48.2 -32.7 -17.2 -1.7 13.8 29.3 44.8 60.0
LONG. 136.8 44.3 20.6 12.5 7.8 4.2 1.0 -2.2 -5.6 -10.0 -16.9
ALT,KM 522.9 525.2 528.9 533.4 538.3 543.2 547.6 551.4 554.4 556.7 558.1
PASS 29062 DATE 6/10/84 TIME 42358.- 44775. RUNDATE 1984 264 PLOT QL0017 1 SPIN AVERAGE EEM

Figure 9

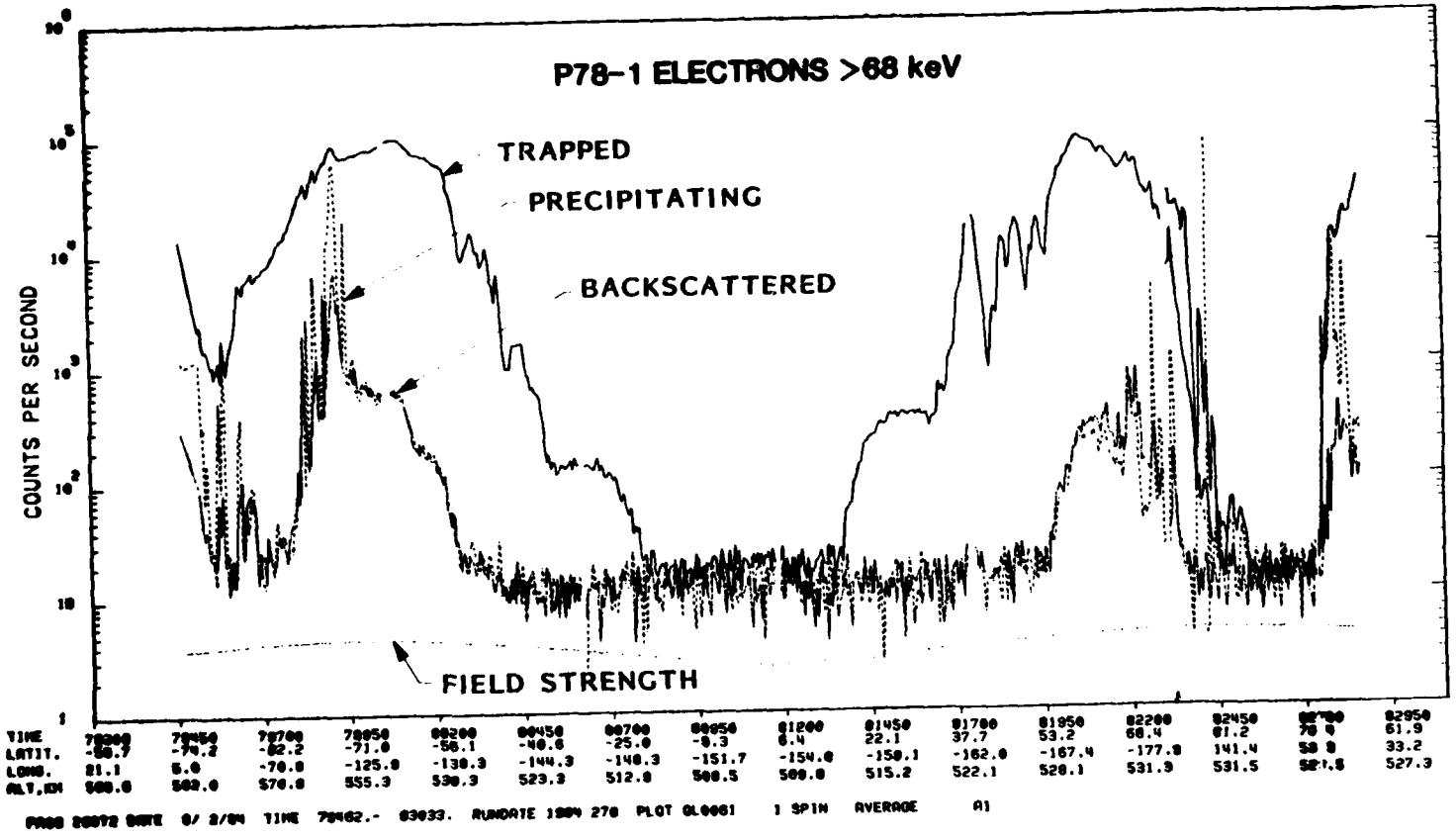

P78-1 ELECTRONS >68 keV
TRAPPED
PRECIPITATING
BACKSCATTERED
FIELD STRENGTH
COUNTS PER SECOND
TIME
LATIT.
LONG.
ALT.KM

Figure 10

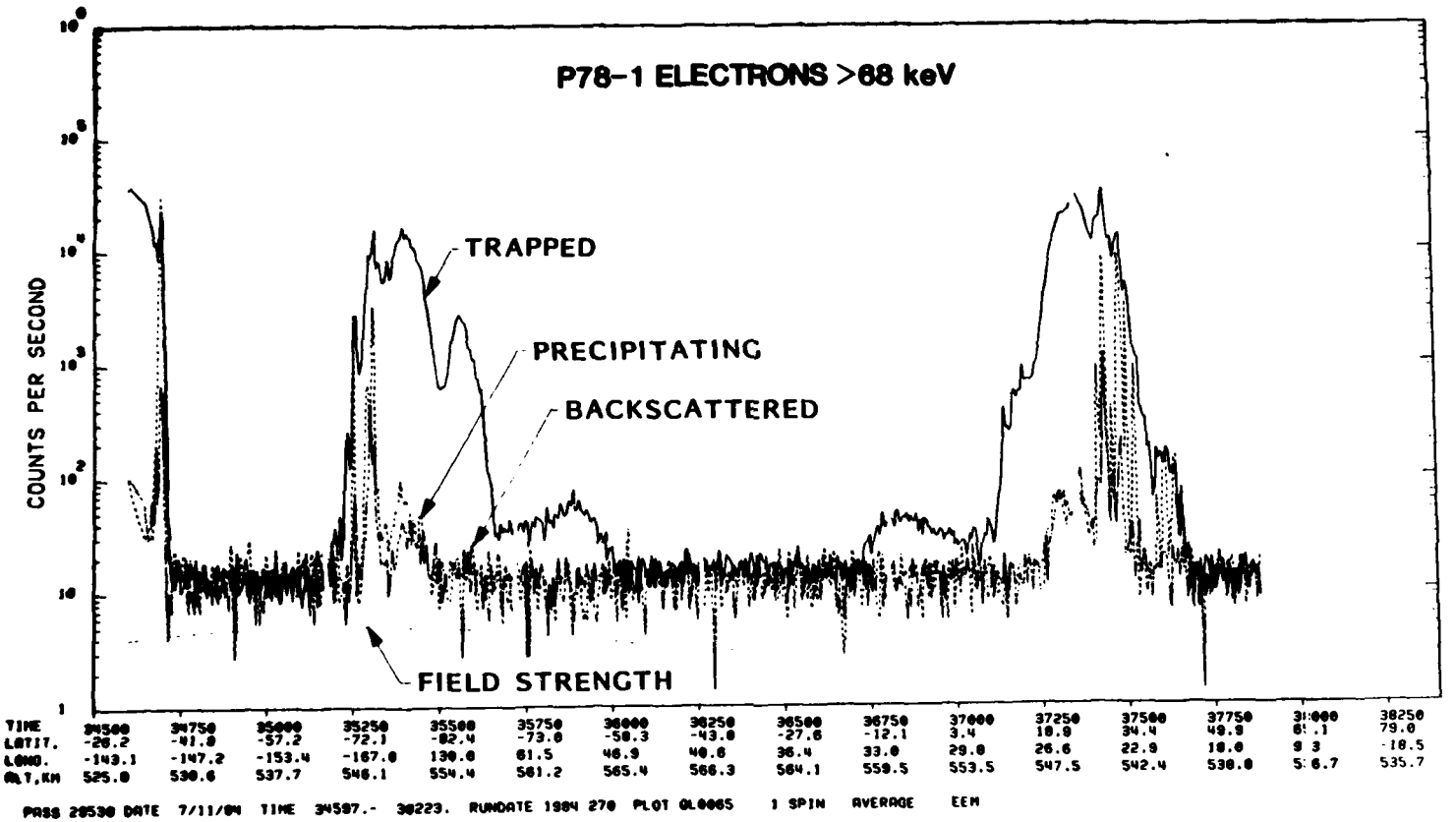

P78-1 ELECTRONS >68 keV
COUNTS PER SECOND
TRAPPED
PRECIPITATING
BACKSCATTERED
FIELD STRENGTH
TIME 34500 34750 35000 35250 35500 35750 36000 36250 36500 36750 37000 37250 37500 37750 38000 38250
LATIT. -26.2 -41.8 -57.2 -72.1 -82.4 -73.0 -58.3 -43.8 -27.6 -12.1 3.4 18.8 34.4 49.8 64.1 79.0
LONG. -143.1 -147.2 -153.4 -167.8 130.8 61.5 46.9 40.8 36.4 33.0 29.8 26.6 22.9 18.8 9.3 -18.5
ALT,KM 525.8 530.6 537.7 548.1 554.4 561.2 565.4 566.3 564.1 559.5 553.5 547.5 542.4 538.8 536.7 535.7
PASS 28530 DATE 7/11/84 TIME 34587.- 38223. RUNDATE 1984 270 PLOT QL0005 1 SPIN AVERAGE EEM

Figure 11

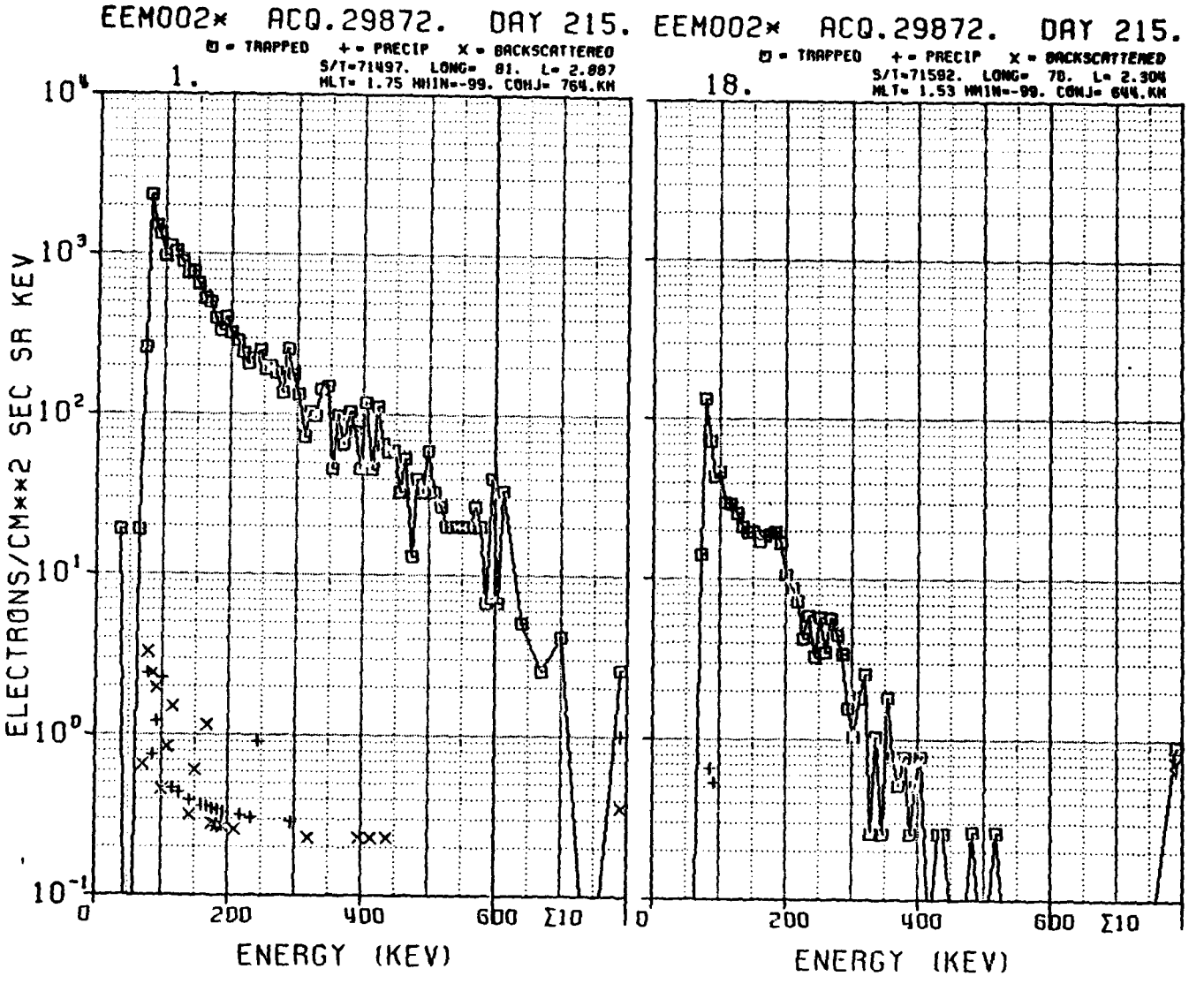

EEM002* ACQ.29872. DAY 215.
□ = TRAPPED + = PRECIP X = BACKSCATTERED
S/T=71497. LONG= 81. L= 2.087
MLT= 1.75 MMIN=-99. CONJ= 764.KM
1.
EEM002* ACQ.29872. DAY 215.
□ = TRAPPED + = PRECIP X = BACKSCATTERED
S/T=71592. LONG= 78. L= 2.304
MLT= 1.53 MMIN=-99. CONJ= 644.KM
18.
ELECTRONS/CM**2 SEC SR KEV
10^4
10^3
10^2
10^1
10^0
10^{-1}
0
200
400
600
Σ10
ENERGY (KEV)

Figure 12

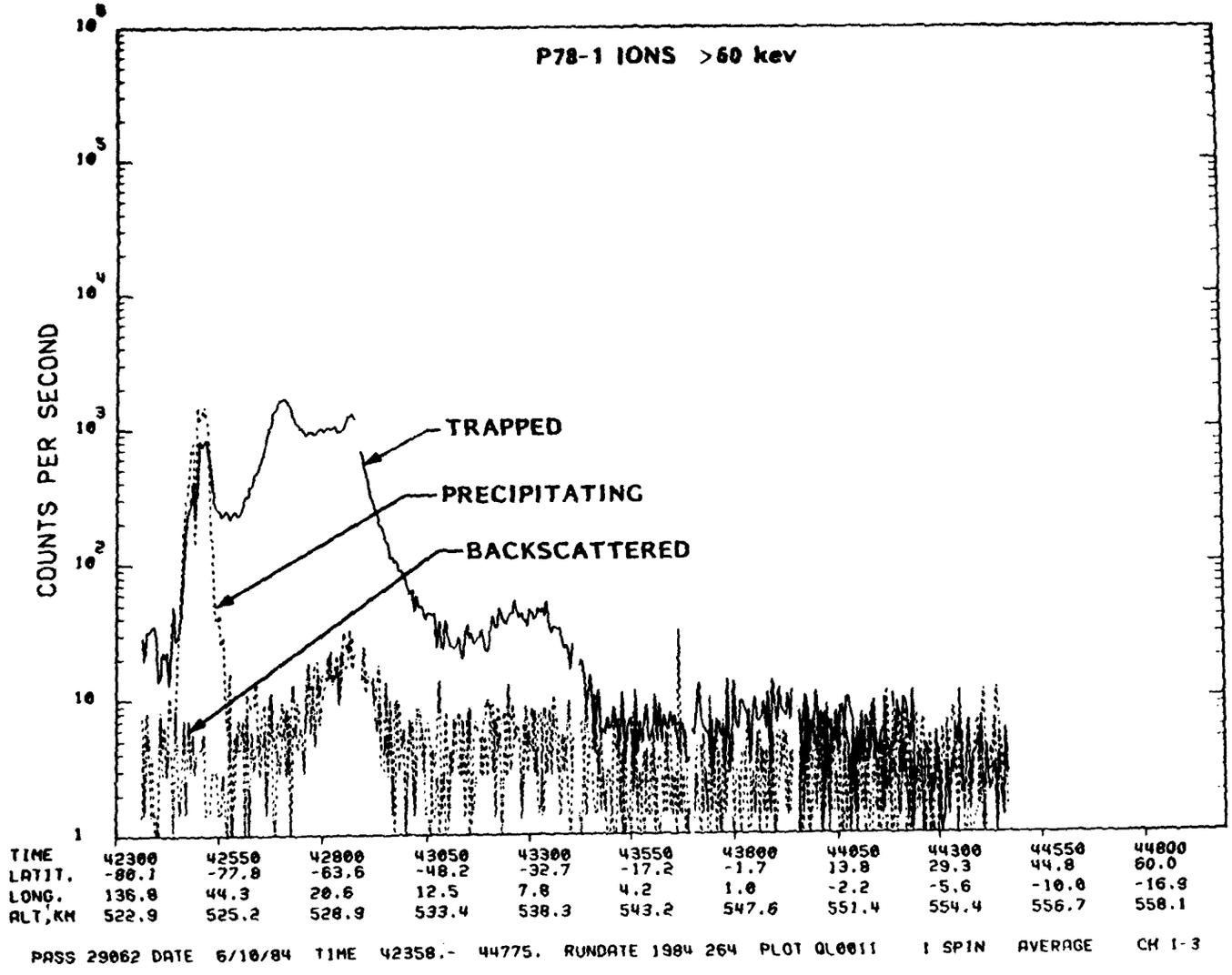

P78-1 IONS >60 kev
COUNTS PER SECOND
TRAPPED
PRECIPITATING
BACKSCATTERED
TIME 42300 42550 42800 43050 43300 43550 43800 44050 44300 44550 44800
LATIT. -80.1 -77.8 -63.6 -48.2 -32.7 -17.2 -1.7 13.8 29.3 44.8 60.0
LONG. 136.8 44.3 20.6 12.5 7.8 4.2 1.6 -2.2 -5.6 -10.0 -16.9
ALT,KM 522.9 525.2 528.9 533.4 538.3 543.2 547.6 551.4 554.4 556.7 558.1
PASS 29062 DATE 6/10/84 TIME 42358.- 44775. RUNDATE 1984 264 PLOT QL0611 1 SPIN AVERAGE CH 1-3

Figure 13

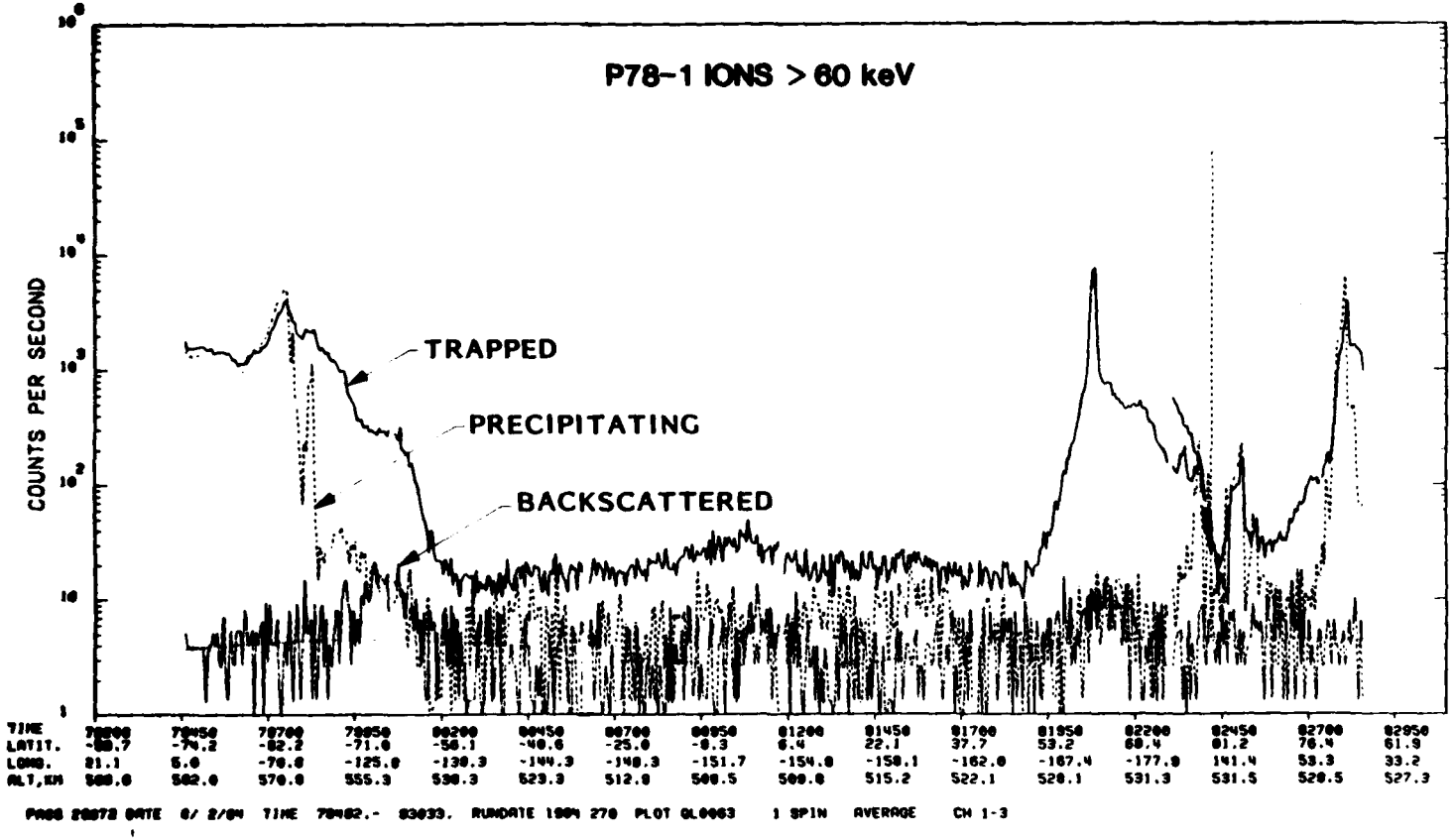

P78-1 IONS > 60 keV
COUNTS PER SECOND
TRAPPED
PRECIPITATING
BACKSCATTERED
TIME
LATIT.
LONG.
ALT,KM
PASS 20872 DATE 6/ 2/80 TIME 78482.- 83033. RUNDATE 1980 270 PLOT GL0063 1 SPIN AVERAGE CH 1-3

Figure 14

END

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